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(54) **A semiconductor device having a container sealed with a solder of low melting point.**

(57) A semiconductor device forming a hermetically sealed housing for a semiconductor element, comprising a base member, a wall member surrounding the semiconductor element, and a cover hermetically sealed to the wall member. According to the invention, an intermediate annular member (17) is interposed between the cover (11) and wall member (12'), the intermediate member being attached to the cover by a solder glass (16) and exhibiting a metal surface facing the wall member for being attached to the wall member by metallic solder. A protrusion (15) of the wall member (12') fully or partly surrounds the intermediate member (17) and is also attached thereto by metallic solder. This structure enables the manufacture of a perfectly sealed housing without applying excessive heat to the assembled device which may damage the semiconductor element.

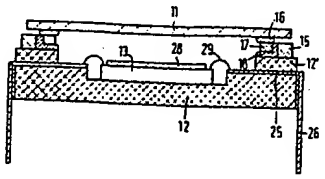

Fig.2

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other hand, some resin solder have a low melting point of 150°C, but they have a relatively high water vapor permeability so that ambient moisture can penetrate the container, after the semiconductor element has been sealed into the container, thereby deteriorating the characteristics of the semiconductor element.

The container in the prior art has another defect that the positional relationship between the cover member and the wall member is liable to be displaced when the cover member is fixed to the wall member, thereby reducing the production yield.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to provide a semiconductor device having a container which can safely seal a semiconductor element having a low heat resistance.

Another object of the present invention is to provide a semiconductor device having a container, which has excellent hermetic properties, and which can be fabricated with a high yield.

According to the present invention, a semiconductor device comprises: a semiconductor element; a container main body having an area for mounting the semiconductor element thereon, and a protrusion around the surface of the outer periphery of the element mounting area; a cap member

Fig.4

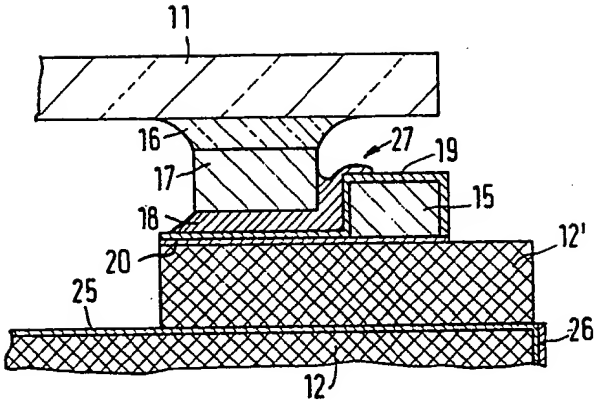
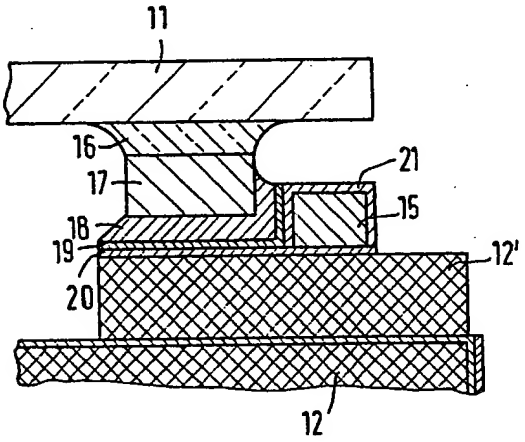


Fig.5



The solder glass and the metallic solder can withstand the water vapor permeance, preventing moisture from penetrating from the atmosphere. In other words, the hermetic properties are excellent, because of non-use of resin adhesives. Thanks to the formation of the protrusion on the container main body, moreover, the passage by which the moisture may penetrate through the metallic soldering material is bent and elongated. As a result, the hermetic properties of the container are further improved.

Another effect is caused by the presence of the protrusion on the container main body. The production yield can be increased because there is no positional displacement between the container main body and the cap member. The presence of that protrusion makes it remarkably easy to determine the position of the cap member on the container body and fix their relationship during the sealing step using the metallic soldering material, thereby increasing the fabrication efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will be explained more fully in the following detailed description taken in conjunction with the accompanying drawings, wherein:

ceramic sheets together with metallic layers 5 which are used for leading out the electrodes of a semiconductor element 3. These metallic layers 5 are formed up to the sides of the base member 2. External leads 6 are soldered or welded to the metallic layers 5. The base member 2 has a recess on which the semiconductor element 3 such as a linear image sensor element requiring no filter is soldered. The electrodes of this semiconductor element 3 are electrically connected to the metallic layers 5 by the wire bonding method.

After this construction has been completed, a cap member 1 made of transparent glass or sapphire is attached to the wall member 2' of the container main body by an adhesive 4. The adhesive 4 is, for example, a solder glass having a low melting point. In this case, the cap member 1 is attached at a temperature of about 400°C. This temperature does not damage the semiconductor element itself, but damages a resin filter which is placed over the semiconductor element such as an area image sensor.

If a resin solder is alternatively used as the adhesive 4, the sealing temperature could be lowered to 150°C to prevent the above shortcoming. But it brings another shortcoming that moisture penetrates the resin adhesive from the outside to induce the deterioration of the semiconductor element 4, etc. In other words, the resin solder has inferior hermetic properties against water vapor

A metal frame 15 made of an alloy of nickel, cobalt and iron, is soldered to the metal layer 20 by a metallic soldering material having a relatively high melting point. As the metallic sodering material, an alloy of silver and copper (a melting point of 779°C to 870°C), silver (a melting point of 961° C) or copper (a melting point of 1083° C) is preferably employed. The metal frame 5 used has a height of 0.2 mm to 0.7 mm and a width of 0.3 mm to 1.0 mm. The metal frame 15 may either be formed all around the periphery of the wall member 12', or be arranged with some parts removed, i.e., in the shape of a broken line.

The exposed surface of the metal layer 20 and the surface of the metal frame 15 are plated with a layer 19 of gold or another metal selected from the group of metals having an excellent wettability with a metallic soldering material 18 such as tin, copper and silver.

On the other hand, the cap assembly is made of the cap member 11 and the metal frame 17. The metal frame 17 is made of an alloy of nickel, cobalt and iron or an alloy of iron and nickel and attached to a cap member 11 made of sapphire or transparent glass by a solder glass 16 such as a glass of $PbO-B_2O_3$ system. The metal frame 17 thus attached is positioned at a slight distance from the inner side wall of the metal frame 15. The solder glass has a softening point between 300°C and 350°C. Therefore, the soldering process is conducted at a temperature of 400°C

According to the construction thus far described, since the soldering process can be conducted at a temperature of at most 200°C after the semiconductor element 13 has been mounted on the base member 12, the resin filter 28 placed over the semiconductor element 13 is not damaged.

Moreover, since the metal frames 17 and 15 are laterally overlapped in the final construction, the passage of moisture from the outside to the inside of the container, which is via the metallic soldering material 18, is bent and elongated. As a result, the airtightness is further improved to prevent the characteristics of the semiconductor element 13 from deteriorating due to the penetration of moisture.

The metal frame 15 can provide a reference for alighment when the cap member 11 is laid on and attached to the wall member 12', thereby facilitating the positioning process. In more detail, the relative positions of the cap member 11 and the wall member 12' are liable to be displaced when the metallic soldering material 18 is heated and melted. Since, however, the metal frame 15 has already been attached to the wall member 12', the relationship of the positions is unchanged. Thus, the semiconductor element can be sealed into the container hermetically with a high yield.

made of the same material, e.g. alumina ceramic, as the wall member 12". According to one method of fabrication, green sheet of alumina ceramic is shaped into two parts which are integrated with the base member 12 by a sintering process. A tungsten-metallized and nickel-plated layer 20 whose surface is plated with gold (19) is limited to the surface facing the metal frame 17. The other parts are constructed similarly to the Embodiment 1.

The fabrication can thus be simplieifed with the characteristics of the device of embodiment 1 unchanged. Further, ceramics have an intrinsically bad wettability with the metallic soldering material 18. This fact causes no problems of bad appearance due to the extrusion of metallic soldering material.

This means that, the material forming the frame 15 (as shown in Figs. 3 and 5) is not limited to a metallic one, but may be an insulating one such as a ceramic. If the frame 15 is made of such a material that has a bad wettability with the metallic soldering material 18, at least the part facing the metal frame 17 has to be formed with a surface layer having an excellent wettability with the metallic soldering material 18.

Embodiment 3

According to this embodiment, as shown in Fig. 8, a metal frame 15' is positioned inside the metal frame 17,

present invention can be applied to other general semiconductor elements.

5. The semiconductor device as claimed in Claim 4, wherein said cap member is made of an optically transparent material.

6. The semiconductor device as claimed in Claim 2, wherein said second frame is made integrally of the same material as that of said wall member.

7. The semiconductor device as claimed in Claim 6, wherein said cap member is made of an optically transparent material.

8. A semiconductor device comprising: a semiconductor element; a base member supporting said semiconductor element thereon; a wall member supported on said base member and enclosing said semiconductor element; a first frame attached onto said wall member while substantially enclosing said semiconductor element; a second frame overlaid on and attached to said wall member by a metallic soldering material such that said metallic soldering material fills up the gap between said first and second frames, and such that it encloses said second frame; and a cap member attached to said second frame by a glassy adhesive.

9. The semiconductor device as claimed in Claim 8, wherein said first and second frames at least partially overlap in the direction of their widths.

16. The semiconductor device as claimed in Claim 9, wherein the surface of said first frame which faces said cap member has a poor wettability with said metallic soldering material.